Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/357
USSR
February 1964
Original: RUSSIAN

Confidential until official release during Conference

Abstract

AN INFLUENCE OF CROSS-SECTION RESONANT STRUCTURE ON NEUTRON DIFFUSION AND MODERATION AND RESONANCE EFFECTS FOR FISSIONABLE NUCLEI

L.P. Agabyan, I.I. Bondarenko and A.G. Gordeev

The way of taking into account the resonant structure of neutron cross-section in the reactor theory is considered. These effects are shown to be of considerable and sometimes of major importance for the determination of neutron space energy distributions even for the fast reactors.

The method is developed for taking into account the resonant structure in multigroup reactor calculation for Pn- and Sn-approximations.

The theory for evaluation of resonant structure parameters is described for different energy ranges. For isolated levels this theory is rigorous but only qualitative estimates of the effects in question can be made for partially overlapping resonances.

It is shown also that because of the interference between potential and resonant scattering the cross-section fluctuations in the region of overlapping resonances are strong enough for resonant self-shielding to be quite significant in this energy range.

Theoretical conclusions need experimental proof. In this report some methods are described for measuring parameters of resonant structure of cross-sections which affect the neutron diffusion in media. These methods do not require high energy resolution and can be applied at any neutron energy including the region of overlapping levels.

The experimental results obtained by these methods are summarized and compared with the theory.

Translation provided by courtesy of the submitting Government

The mean values and statistical distributions of fission width are important characteristics of the resonant structure. Some theoretical conceptions on fission-channel scheme were used to make reasonable choice of these characteristics. The Bohr-Wheeler formula for average fission-widths was used to analyze experimental data for reactions (d,pf), (n,f) and (γ,f). These data are found to be in agreement with the conception of fission channels proposed by O. Bohr, negative parity channels being by 0.6–0.8 MeV above the first positive parity channel. In this case the Bohr-Wheeler formula is shown to describe quantitatively the fission widths of neutron resonance of U^{233}, U^{235} and Pu^{242}. One must assume Pu^{239} having the ground state of negative parity to explain the sharp disagreement between theory and experiment for this nucleus.

Experimental distributions of fission and reduced neutron widths of neutron resonances were analyzed. The existence of two sub-systems of resonances with different spins and possible omission of weak levels were taken into account. Resulting numbers of fission channels are N = 1 for Pu^{239} and N $\geq$ 3 for U^{233}.

The dependence of $\bar{\alpha} = \frac{\bar{\sigma}\gamma}{\sigma}$ on energy for s- neutrons was calculated ($\alpha = \frac{\bar{\Gamma}\gamma}{F_t}$ was taken to be constant). $\bar{\alpha} > \alpha$ always the difference between two values being especially large at neutron energy En$\sim$100 eV. With an increase in neutron energy when the contribution of neutron width increases and fluctuations of the total width decrease, the value of $\bar{\alpha}$ approaches α, i.e. diminishes even before neutron p-wave becomes significant. The maximum effect of this kind is expected for Pu^{239} - the nucleus with the most broad distribution of fission widths and with greatest reduced neutron width.

These results were also used for calculating temperature effect for Pu^{239}.